

## Space design quality and its importance to sustainable construction: the case of hospital buildings

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**ABSTRACT:** The hospital project, more than any other, requires a number of concerns related with the satisfaction and well being of working teams, patient, administration and other officials. In this context it is possible to say that the healthcare spaces design are fundamental for the best work, functionality, results and to improve the best practices for a sustainable building. The volume and organization of these spaces are very important and can be decisive in environmental, economic and social development of the whole building. Therefore this study is focused in the space design quality and how its organization, flexibility and adaptability can be fundamental for the well being of people and for the best results in the sustainability of construction and will highlight how building sustainability assessment tools consider and evaluate these aspects. It is fundamental to propose the best way to promote the investment in the hospital design space to support the design team in the adoption of space solutions that contribute to the sustainability of these buildings.

### 1 HOSPITAL BUILDINGS

#### 1.1 *The architectural influence*

In Europe, approximately 10% of the GDP of each country is used in healthcare buildings and, according to the 2008 data, this type of constructions contributes about 5% of CO<sub>2</sub> emissions from European Union Countries (Vaquero, 2013). The intensive use of energy resources, water resources, waste production, etc., in the hospital buildings brought this type of buildings to the discussions in the field of sustainability. However, today, reality shows that there are still some hospital's management units that do not give attention to the efficiency of these buildings and to the implementation of better practices. Fortunately, there has been in Portugal, and in many other countries, an awareness of the relevance of these issues and the need to increase the efficiency of these buildings.

Early environmental design initiatives were focusing only on the reduction of energy demands. Different institutes and governmental initiatives developed tools and policies to address this problem. In 1980s and 1990s some of the initiatives began to reflect concerns about the sustainability of the construction industry, and in 1993 the UIA/AIA World Congress of Architects concluded that it was a bold challenge to the profession of an architect to put a broader sustainability agenda into practice (Guenther & Vittori, 2008). In 2000 many of these initiatives turned to incorporate sustainable design strategies as basic and fundamental in standard practice. In 2005, the American Institute of Architects (AIA) established a more aggressive position on the responsibility of design professionals, defending the position that the architects must change the professional actions and work together with the clients changing the actual paradigm of designing and operating a building (AIA, 2005).

The sustainable project requires a revolution in the way of thinking the building design. So it is important that this transformation, that across all phases of the life cycle building, will be reflected in the early stage of architectural design and in the essence of it: the design and organization of space. If the architectural design should consider the whole patient and users' needs, environmental concerns and generate synergies among all actors of the design team, then this should be directly addressed in building sustainability assessment tools. This is essential in order to support architects during the early phases of design and to recognize the efforts of an architect in designing a truly sustainable building.

Michael Lerner (2000) formulated the following question: *“The question is whether healthcare professionals can begin to recognize the environmental consequences of our operations and put our own house in order”* (Roberts & Guenther, 2006). This is not a trivial question, but the foundation of all other issues that may arise around this same concern (Roberts & Guenther, 2006). Based on this, Figure 1 illustrates the relationship between human health, medical treatment and environmental pollution that directly affects the mission of the healthcare industry.

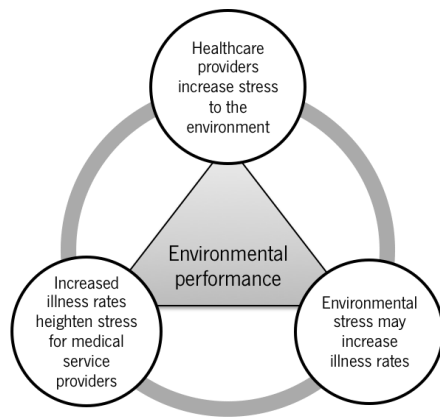


Figure 1. Relationship between environmental performance and healthcare (Roberts & Guenther, 2006)

## 1.2 Space design quality

Several studies and professionals agree that it is possible to work through the weaknesses of actions and measures, some of them simple and inexpensive, but capable of reducing the environmental impact. In order to introduce sustainable practices in the design of healthcare buildings, several countries have published guidelines to promote improved design approaches. Among them, it is possible to highlight recommendations for hospital projects that the Green Building Committee of the American Society of Healthcare Engineering (ASHE) published in 2002 (Robert & Guenther, 2006). This partnership between the American Hospital Associations and the United States Environmental Protection Agency, pointed out the principles of sustainable architecture that are intended to reduce waste and other impacts associated with hospitals (Robert & Guenther, 2006). The ASHE proposes an architectural development of these recommendations in order to develop buildings capable of improving the health concerns at three scales (Robert & Guenther, 2006):

- Protecting the immediate health of building occupants;
- Protecting the health of the surrounding community;
- Protecting the health of the larger global community.

As presented in Figure 2, this “Triple Bottom Line for Health” defines the industry approach to sustainable building and operations and is the basis for the most relevant design tolls and guidance documents that have been developed for the purpose of making known healthcare organizations and your designers these challenges (Robert & Guenther, 2006). However, these assumptions increase its high complexity when consider the interests of the community and the population, which can also lead to failure of the same at its misapplication. In this sense the

health industry should make an effort to take into account not only the technical needs of the hospital, the patients, the environment, but also the community at large (Figure 3).



Figure 2. The Triple Bottom Line for Health (Roberts & Guenther, 2006)

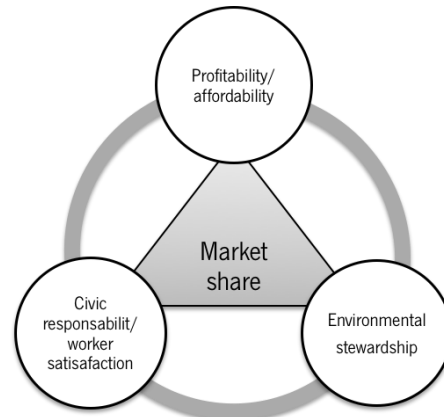


Figure 3. Applying the Triple Bottom Line Approach at the Community Level (Roberts & Guenther, 2006)

Healthcare is one of the most complex and rapidly changing industries. It is continually transformed by new technologies, technique, pharmaceuticals and delivery systems (Boone, 2012). Meanwhile, it is known that the use of different resources of the hospital who lives largely dependent on the: shape of building(s), construction and arrangement of the ground; climate in which it operates; relation of different design spaces; composition of circulation, waiting, service and operation areas; and functional program. In this concern, it is a fact that the hospital architecture incorporates a development project that has as main concerns the adequacy of technological advances in medicine, compliance with rules and regulations (that seek to ensure the quality of designed environments), the complexity and flexibility required for the project and the high cost of premises. This means that the designer often forgets or not gives the adequate importance to sustainable principles that this type of project should follow (Shaw et al, 2010). Consequently the construction of this type of buildings needs to incorporate this evolution and the spaces design can be the way to improve healthcare. The architectural design of the space, its organization, operation and configuration, allows these buildings to respond and adapt positively to the needs for which they are designed. At an early stage, a good investment in their flexible design reduces the need for further improvements (Johnson, 2010).

Analysing the indicators and parameters of the Building Sustainability Assessment (BSA) tools, specifically oriented to hospital buildings, it is possible to assess how important is the use of these methodologies in the architecture design phase to promote the existence of more sustainable buildings in the future. Many of these parameters are easily answered through the spatial and volumetric organization of indoor and outdoor spaces (Castro, et al. 2013). Therefore it is important to encourage the architects to incorporate these concerns in their projects, avoiding solving future problems resulting from the addition of equipment or other solutions that increase energy consumption, water or other resources, even human. Most times, sustainability assessments are used to comparatively classify the buildings. Nevertheless it is of increasingly importance that such methods are regarded as ordinary work tools in all project phases.

## 2 BUILDING SUSTAINABLE ASSESSMENT TOOLS

### 2.1 *The patient well being*

The hospital project contains different aspects from the most common projects of residential buildings, offices or services. In common buildings, sometimes the user and the client are the same and when they are not, setting the requirements is not difficult since they are common to

most inhabitants. In the case of hospital buildings this is not the reality and the project team is usually hired for the purpose of designing a building that includes different spaces and different users, such as doctors, nurses, patients, visitors, cleaning staff, administrators, and others (Castro, et al., 2012). In this sense it is important to combine different spatial needs, which are always subject to constant changes throughout its period of use due to new features, innovations, needs expansion and new treatment methods (Figueiredo, 2008).

With the evolution of such buildings, it seems that the patient is increasingly occupying a central place of every concern and attention. Thus there should be a paradigm shift in the way these buildings are designed and the patient should be considered as the final customer of these structures (Figure 4).



Figure 4. Life cycle of hospital buildings (Figueiredo, 2008)

One of the researchers that developed an important work related with human needs is Abraham Maslow, which grouped, in 1987, all human needs into a hierarchy: physiological; safety; social; esteem; and self-actualization. In this concern, the Institute of Medicine's (IOM), defined, in 2001, its priorities based on the Maslow's hierarchy, declaring that healthcare must be: safe; effective; timely; efficient; equitable; and patient centered (Clark & Malone, 2006).

## 2.2 The contribution of space design to the sustainability of hospital buildings

In Portugal, during 2008, the Ministry of Health developed a document that lists the recommendations and technical specifications for the hospital buildings, where there are recommendations for several issues, such as architecture, facilities and equipment for water supply and drainage, electrical and mechanical systems, centralized technical management, outdoor spaces, integrated management of solid waste, maintenance, etc. Together with this document, there are other regulations that specify the requirements of each specific space at the level of lighting, indoor air quality, temperature and ventilation. Nevertheless, in which regards to the sustainable management of the hospitals there is not any document with the force of law or recommendation.

In 2012, the Regional Health Administration of the Algarve summarized, in a manual, the good practices in sustainability health sector, which are divided into four main topics: Air quality and energy efficiency; Quality and availability of water; Resources and waste; and Quality of life. This manual aims to encourage the implementation of best mitigation and rehabilitation practices in the 218 units of national healthcare and is a good initiative to attract the attention of decision makers involved in the regeneration of this type of buildings. Nevertheless the design quality of the space is in most cases superficially addressed, eventually giving more importance to the introduction or modification of equipment and building elements improvements that make up the building.

Summarily the sustainable design of hospital buildings will result in competitive advantage strategies, as well as better economic, environmental and social efficiency. Thus, grouping the principles advocated by several authors, the main principles that support the sustainable design and construction of this type of buildings are (Castro, et al., 2012):

- Improve the quality of patient care;

- Reduce the time of patient recovery;
  - Improve operational efficiency and productivity;
  - Create increased facilities for users and surrounding communities;
  - Contribute to the satisfaction and consequent fixation of employees and the experience positive patient (system performance evaluation of the complex);
  - Develop quality and safe indoor and outdoor environments;
  - Reduce operational risks associated with the project
  - Increase the lifetime of the building;
  - Reduce construction, operating and maintenance costs;
  - Educate the understanding for the need to use a sustainability certification, allowing it to assess the pros and cons of introducing these design practices.
- Thinking about these concerns it is also important thinking about this buildings' life cycle that need to include even more concerns compared to other type of buildings (Figure 5).

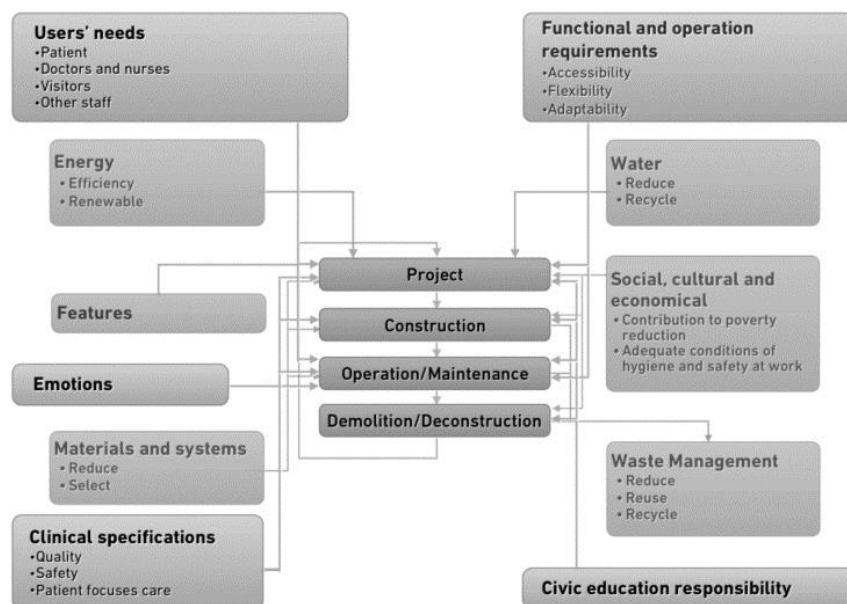


Figure 5. Life cycle of hospital buildings

### 3 BUILDING SUSTAINABLE ASSESSMENT TOOL FOR HOSPITAL BUILDINGS

#### 3.1 Existing tools

All over the world there is a growing number of sustainability assessment tools developed for the building sector and oriented for new constructions, existing buildings and refurbishment/rehabilitation operations. Inside these three groups, most assessment tools are specifically oriented for different type of buildings. In the context of hospital buildings the most well known tools are: BREEAM Healthcare, LEED for Healthcare and Green Star – Healthcare (BREEAM, 2013; LEED, 2013; GBCA, 2013). In addition to these, DGNB is developing a specific methodology for hospitals that is not finished yet, and CASBEE has a system for *new construction* that includes the hospital buildings in the category of residential buildings. Nevertheless the CASBEE tool does not specifically address this type of buildings, but is one tool with different specifications for residential and non-residential buildings. For this reason, this study is focused on BREEAM Healthcare, LEED for Healthcare and Green Star - Healthcare.

The three abovementioned tools have a system of evaluation based in points that are divided over different categories, each of which is based in a series of evaluation parameters (Sauders, 2008). They have similar structure and similar list of criteria, which highlight the main aspects that initially started worrying humanity when we began to speak about the concept of sustainable development: Energy; Water; Materials; Pollution; and waste (Figure 6).

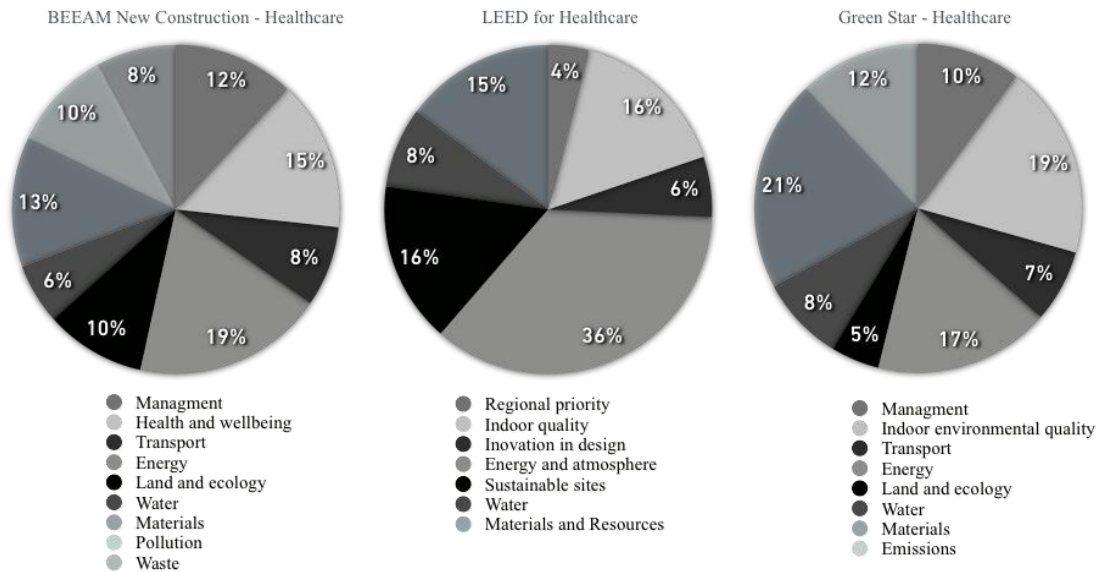


Figure 6. Criteria of the three most well known tools for healthcare

These criteria are absolutely important, but they are too much focused on environmental issues. At the moment we need to think about more parameters and more human requirements. These tools need to be more balanced on the level of the three pillars of sustainable development, namely: Environmental; Social; and Economical. Being aware of this, these tools do not consider the aspects of major importance to building designers, that are the functionality and operationally of space and the human requirements. In this scenario they are not generally adopted, because they bring a language that is not the same used by most building designers. Analyzing the indicators of each tool it is possible to conclude that there is no sustainability categories directly related with space design quality. Nevertheless there are some sustainability parameters that are indirectly related with that as the category *Innovation in Design* (that allows getting an extra score in all tools) allows correcting a worst performance in other sustainability categories. Credits for innovative performance are awarded for comprehensive strategies, which demonstrate quantifiable sustainability benefits not specifically addressed by other sustainability categories. Table 1 presents the sustainability parameters of the abovementioned tools that are directly influenced by the indoor and outdoor spaces design quality.

Table 1. Sustainability parameters that are directly influenced by the spaces' design quality

Category Parameters		Tools		
		BREEAM New Construction - Healthcare	LEED for Healthcare	Green Star Healthcare
Sustainable Sites	Light Pollution Reduction		x	
	Connection to the Natural World - Places of Respite		x	
	Connection to the Natural World - Direct Exterior Access for Patients		x	
Health & Wellbeing	Day lighting	x	x	x
	View Out	x	x	x
	Potential for Natural Ventilation	x		x
	Outdoor Space	x		x
	Arts in Health	x		
	Minimum Indoor Air Quality Performance		x	
Energy	Optimize Energy Performance		x	
	Lighting zoning			x
	Car park ventilation			x

Table 1 (cont.). Sustainability parameters that are directly influenced by the spaces' design quality

Category Parameters		Tools		
		BREEAM New Construction - Healthcare	LEED for Healthcare	Green Star Healthcare
Transport	Proximity to amenities	x		
	Pedestrian and Cyclist Facilities	x	x	x
	Maximum Car Parking Capacity	x		x
	Deliveries and Manoeuvring	x		
	Community Mass-transports			x
	Transport design and planning			x
Materials and Resources	Compactor / Baler	x		
	Storage and Collection of Recyclables		x	
	Resource Use - Design for Flexibility		x	
Land Use & Ecology	Reuse of Land	x		x
	Contaminated Land	x		x
	Mitigating ecological impact	x		x
Innovation in Design	Innovation	x		x
	Integrative Project Planning and Design		x	
	Innovation in Design: Specific Title		x	
	Integrative Project Planning and Design		x	

These concerns in an integrated assessment tool to evaluate the sustainability of hospital buildings. The proposal is to divide criteria in three dimensions (environmental, social and functional, and economical) and incorporate the indoor and outdoor spaces design quality especially in the Sociocultural and functional quality category. Putting the patient at the center of concerns, some of the criteria that we proposed to integrate and research are expressed in the Figure 7.

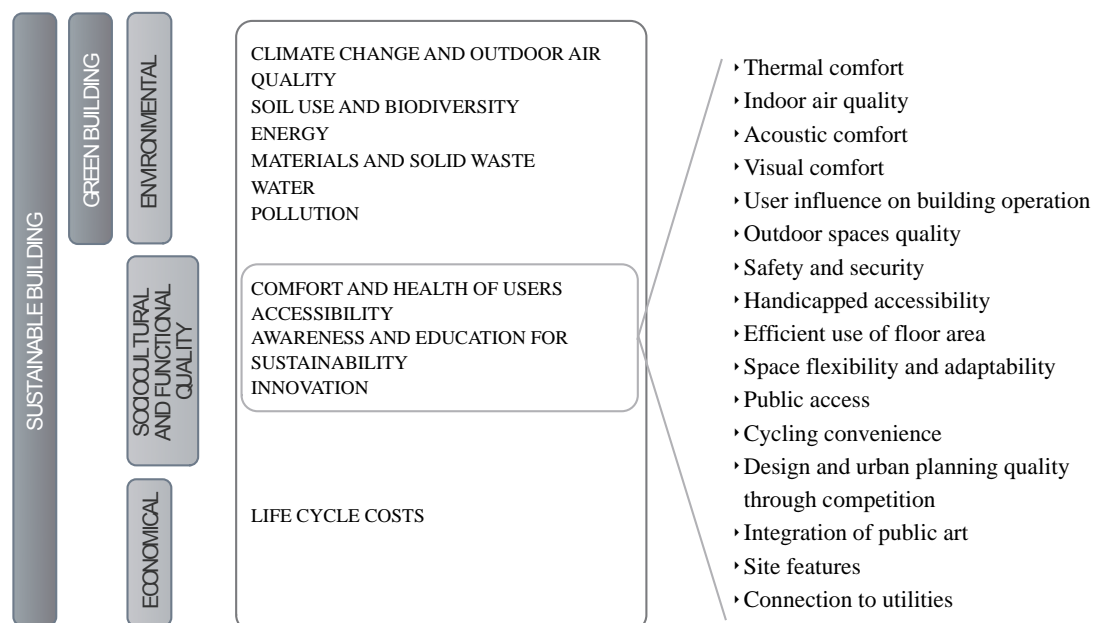


Figure 7. Proposal for structure of hospital buildings BSA tool

## 4 CONCLUSIONS

It is relevant to promote and discuss the importance of the space organization to the sustainable construction and the influence of the architecture (and not only the building systems) in the BSA tools. It is also important that each designer involved in the development and construction of hospital buildings is able to quickly identify a set of parameters that have the greatest influence in the whole building sustainability. All in all these tools must be bivalent, since they must impose the concerns with sustainable construction but also integrate the requirements of each building and each project area, linking priorities and facilitating the widespread integration of several concerns in the different design projects. This is one aspect that can promote the use of these tools by all project teams involved in the construction of this building typology, as well as their use in different phases of buildings life cycle.

### 4.1 Acknowledgement

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